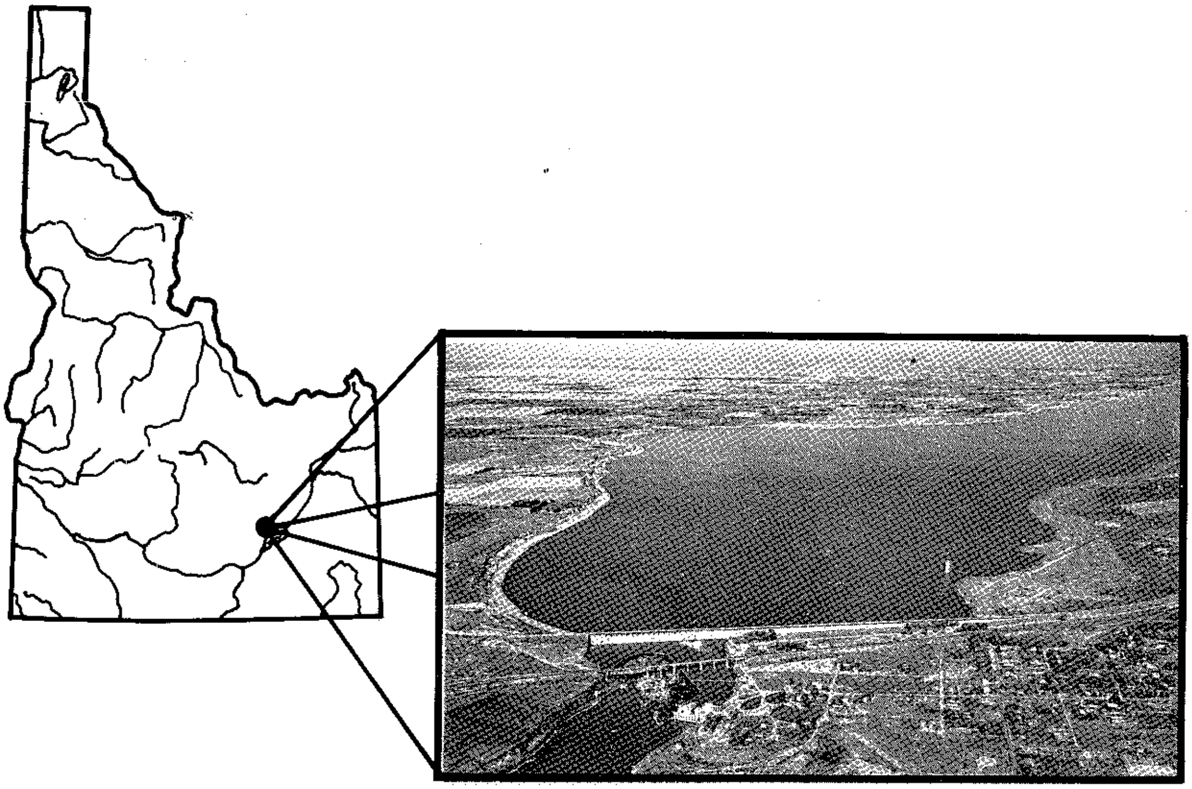
WATER RESOURCES
OF THE
ABERDEEN - SPRINGFIELD AREA, BINGHAM & POWER COUNTIES, IDAHO



IDAHO DEPARTMENT OF WATER ADMINISTRATION

WATER INFORMATION BULLETIN NO. 36

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WATER RESOURCES OF THE ABERDEEN–SPRINGFIELD AREA, BINGHAM AND POWER COUNTIES, IDAHO

by

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Prepared and Published by

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INTRODUCTION

PURPOSES AND OBJECTIVES

The purposes of this study are to assess the effects of recent ground-water development in the Aberdeen-Springfield area, to insure more effective utilization of the resource and to provide greater knowledge of the resource for purposes of water right administration by the Director of the Department of Water Administration.

The specific objectives of the study are as follows:

1. Determine the inflow and change in inflow, if any, to American Falls Reservoir between Blackfoot and American Falls Dam due to well development in the Aberdeen-Springfield area.

2. Determine the degree of well development in the area and the resulting effect upon ground-water levels, quality, and availability.

3. Determine the primary aquifers and their hydrologic characteristics.

4. Update the existing well inventory.

5. Determine the changes in surface-water distribution patterns due to increased ground-water use.

LOCATION AND EXTENT OF STUDY AREA

The Aberdeen-Springfield area, as defined in this report, refers to that area adjacent to the northwest side of American Falls Reservoir and the Snake River between Moreland and American Falls Dam, an area of approximately 540 square miles (fig. 1).

PREVIOUS INVESTIGATIONS

Previous investigations in the area include one by Mansfield (1920), in which he mapped the geology of the northeast end of the reservoir area. Piper (1924) mapped the surficial geology of the southwestern portion of the area. Prior to construction of the American Falls Dam, work by the U. S. Bureau of Reclamation led to a detailed report on the geology of the dam and reservoir sites by W. C. Crosby in January of 1920. T. R. Newell (1928, 1929) completed a detailed hydrologic study of the reservoir area, which included development of a formula still being used by the U. S. Bureau of Reclamation to compute ungaged ground-water inflow to the reservoir. Stearns, Crandall, and Steward (1938), in their study of the ground-water resources of the eastern Snake River, mapped the geology

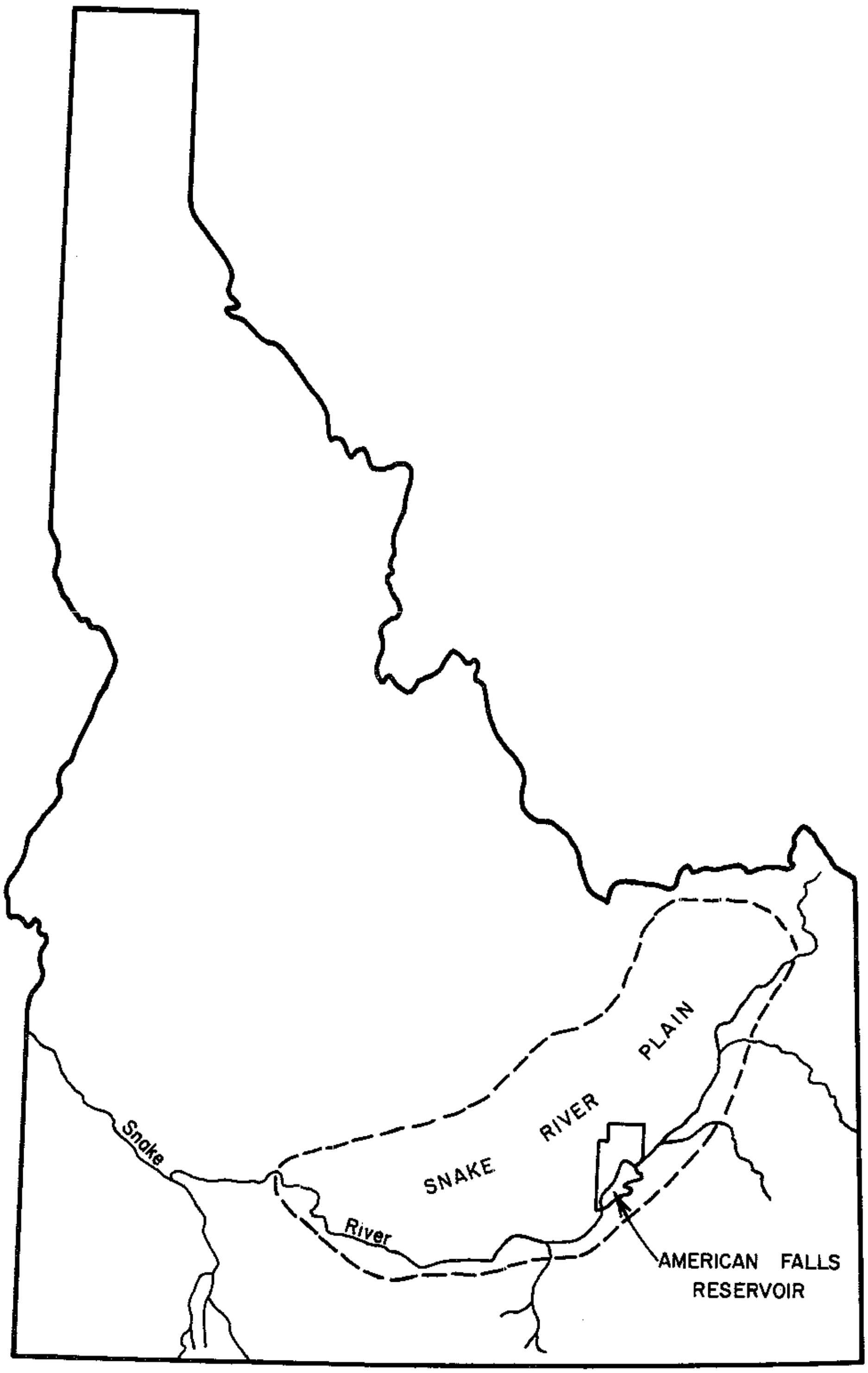

FIGURE 1. Location of Aberdeen-Springfield area, Idaho.

and studied the water resources of the American Falls Reservoir area. The U. S. Bureau of Reclamation in 1950-51 drilled a number of core holes immediately downstream from American Falls Dam, which was followed by the preparation of a detailed geologic map of the reach by Jarrard and Mead (1951, 1952).

The U. S. Geological Survey (USGS), in cooperation with Water District 01 and the Idaho Department of Reclamation (now the Idaho Department of Water Administration), began a continuing program of monitoring of ground-water levels in the area near the reservoir in 1952 (Shuter, 1953; Sisco and Luscombe, 1961). The USGS, in cooperation with the U. S. Bureau of Reclamation, studied the ground-water resources of the Snake Plain, including the American Falls Reservoir area. Mundorff (1967) delineated the ground-water resources in the vicinity of American Falls Reservoir, adding materially to knowledge of the area.

ACKNOWLEDGEMENTS

Special thanks are in order to the Idaho Power Company for its excellent cooperation. Thanks are also due to the personnel of various canal and irrigation companies in the area; the Watermaster and staff of Water District 01; the U. S. Geological Survey, Water Resources Division, Boise; and other State and Federal agencies which provided input to this report. The friendly cooperation extended by the residents of the area, who allowed free access to their land and wells, is also greatly appreciated.

WELL-NUMBERING SYSTEM

The well-numbering system used by the Department of Water Administration in Idaho indicates the locations of wells within the official rectangular subdivisions of the public lands, with reference to the Boise Baseline and Meridian. The first two segments of a number designate the township and range; the third segment gives the section number, followed by two letters and a numeral which indicate, respectively, the quarter section, the forty-acre tract, and the serial number of a well within the tract. If a well has been located to the nearest ten-acre tract, there will be three letters and a numeral following the section number (fig. 2).

Quarter sections are lettered a, b, c, and d in counterclockwise order from the northeast quarter of each section. Within the quarter sections, forty-acre and ten-acre tracts are lettered in the same manner. In the figure shown, well 6S 30E 15adb1 is in the NW¼ of the SE¼ of the NE¼ of Section 15, Township 6 South, Range 30 East, and is the first well designated in that tract.

In the event that a spring is located by this method, a capital "S" is inserted between the third letter and the numeral as follows: 6S 30E 15adbS1.

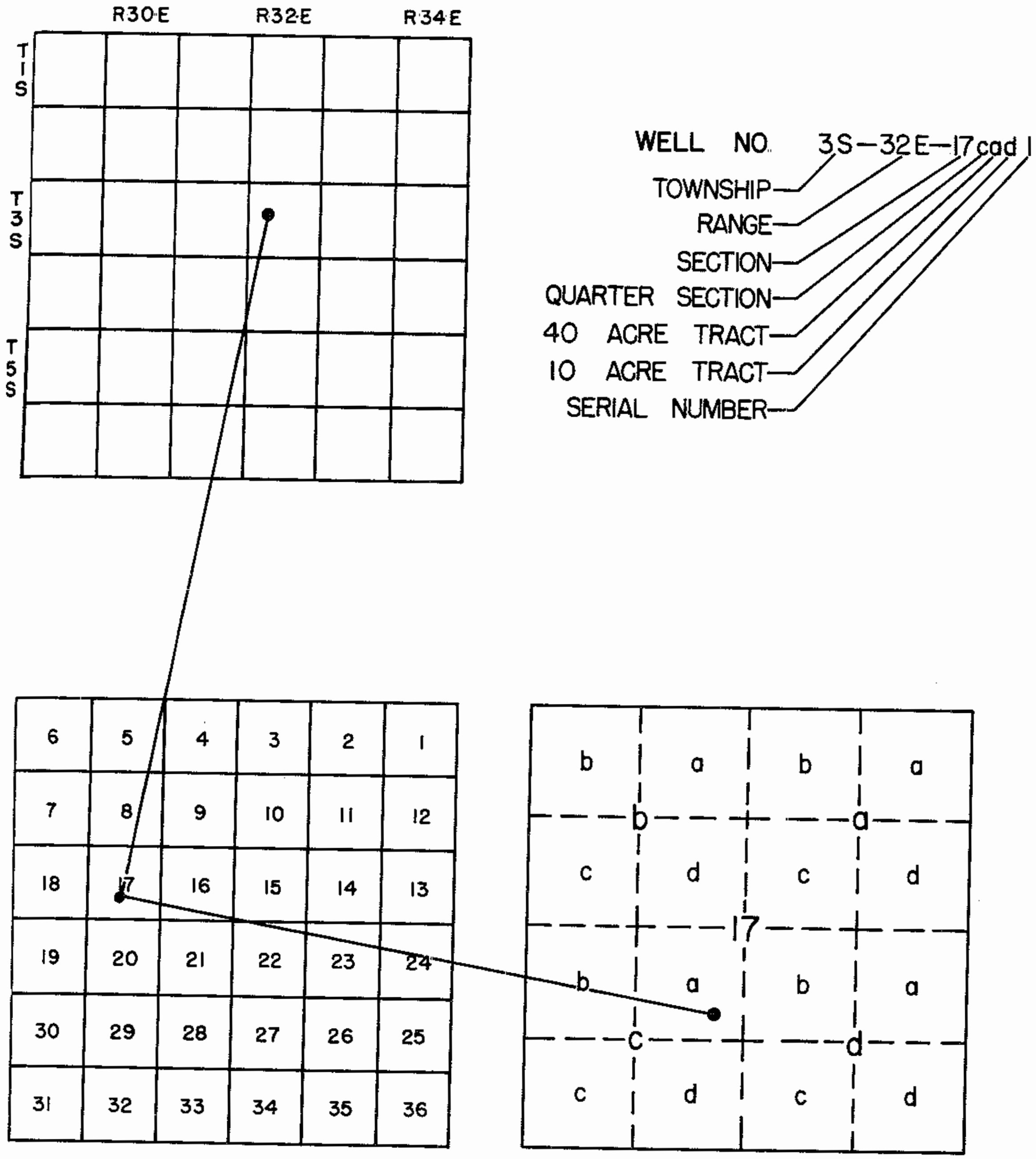

FIGURE 2. Well location system.

GEOGRAPHIC SETTING

GEOGRAPHY

The study area in Bingham and Power Counties is in the Columbia Intermontane Province, of which the Snake River Plain is a part. The Snake River Plain is characterized by gently rolling topography of low relief, with elevations ranging from about 4,600 feet above mean sea level (msl) near Moreland to less than 4,400 feet near American Falls Dam.

American Falls Reservoir forms the major portion of the southeast boundary of the area. Built in 1927, American Falls Reservoir has a capacity of 1.7 million acre-feet, and is used primarily for flood control and irrigation. The Snake River, which enters the reservoir from the northeast, is the major perennial river in the vicinity.

Aberdeen, population 1,542 [1970 Census], is the largest town in the area; other towns and villages include Springfield, Sterling, Pingree, Rockford, Riverside, and Moreland (fig. 3). State Highway 39 serves the area, as well as a branch line of the Union Pacific Railroad. Interstate 15, a major artery, makes the area much more easily accessible from other parts of the State.

Native vegetation in the area consists primarily of sagebrush, rabbit brush, and various grasses. Crops grown include hay, wheat, barley, sugar beets, potatoes, and pasture, all of which require irrigation.

CLIMATE

The climate of the area is semi-arid; precipitation is meager due to the fact the area is surrounded by highlands and is located far inland from the coast. Summers are warm to hot, while, conversely, winters are quite cold.

Specific data regarding the climate of the region were taken from records of weather stations at Pocatello, Blackfoot, American Falls, and Aberdeen. These records show summer maximum temperatures in the 90° - 100° Fahrenheit (F) range, and winter minimum often below zero. Average monthly temperatures for these four stations are shown in table 1. The relative humidity is generally quite low.

Precipitation averages about 12 inches annually, and some occurs each month of the year. Approximately one-third of the precipitation occurs during the months of April, May and June, while one-sixth of the annual precipitation occurs during the driest months of July, August and September.

At the Aberdeen Experiment Station, the average frost-free growing season of 222 days begins approximately March 29th and ends approximately November 6th (Stevlingson and

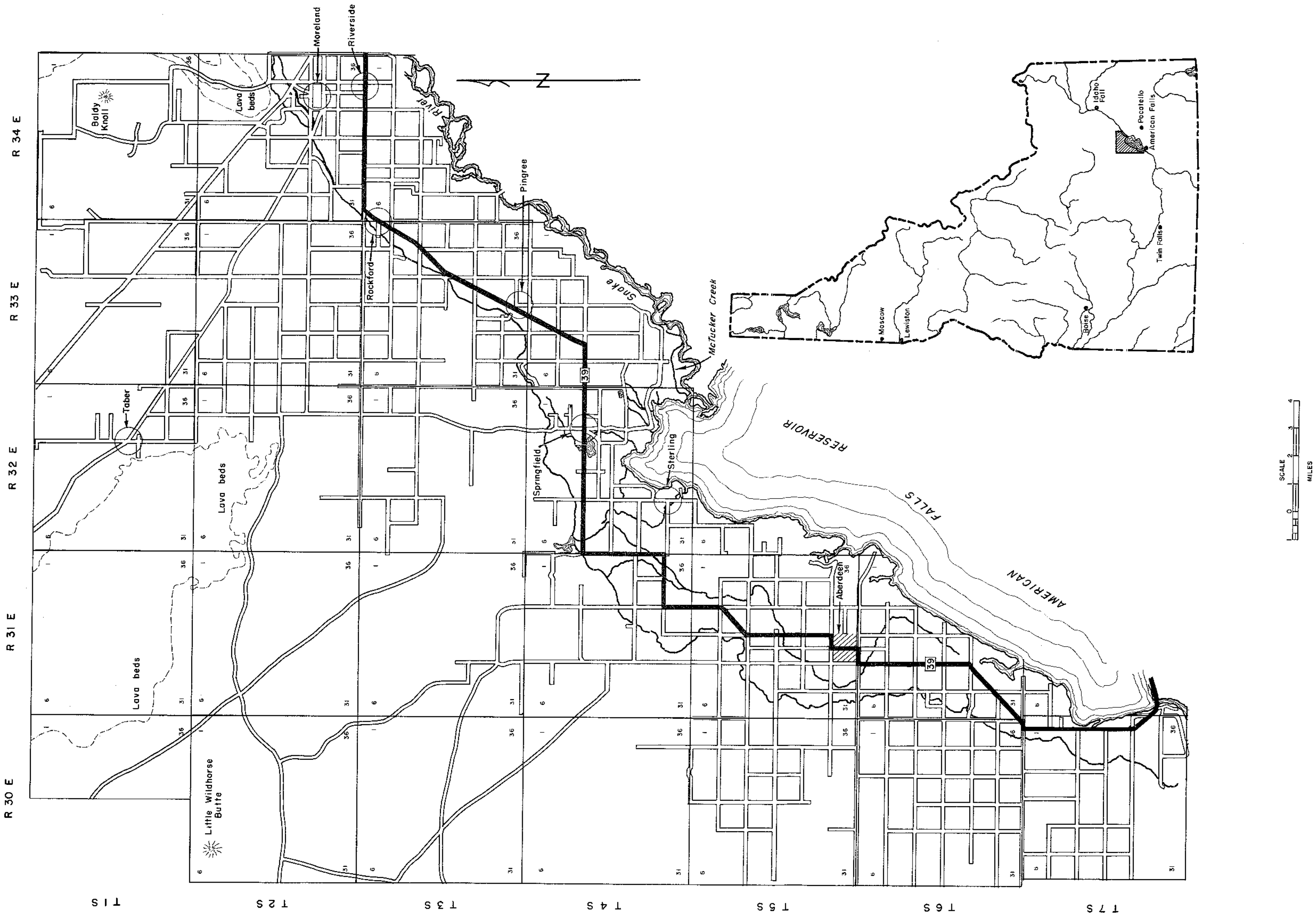

FIGURE 3. Map of Aberdeen-Springfield area, Idaho.

TABLE 1

MEAN MONTHLY PRECIPITATION AND TEMPERATURE AT NATIONAL WEATHER SERVICE STATIONS IN AND ADJACENT TO ABERDEEN–SPRINGFIELD AREA

Station	Aberdeen		American Falls		Blackfoot		Pocatello	
Elevation	4405		4318		4487		4454	
Years of Record	55	49	41	37	56	39	61	51
Month	Precip. (in.)	Temp. (^oF)	Precip. (in.)	Temp. (^oF)	Precip. (in.)	Temp. (^oF)	Precip. (in.)	Temp. (^oF)
January	0.72	20.9	1.25	23.9	1.04	21.8	1.23	24.0
February	0.61	26.8	0.88	29.6	0.83	27.4	0.95	29.5
March	0.66	34.9	0.96	36.1	0.85	35.1	1.04	36.3
April	0.88	44.8	1.14	45.7	0.96	45.8	1.25	45.8
May	1.10	53.9	1.38	54.9	1.25	54.9	1.29	55.1
June	0.90	61.1	1.10	62.0	1.14	62.0	1.07	62.9
July	0.39	69.6	0.59	71.1	0.55	70.8	0.63	72.4
August	0.47	66.0	0.62	69.1	0.59	68.1	0.71	70.1
September	0.59	57.0	0.71	58.2	0.77	58.2	0.81	60.0
October	0.80	46.9	1.10	49.0	0.88	47.8	0.97	49.2
November	0.71	34.4	1.09	36.3	0.96	35.1	1.01	36.3
December	0.76	25.0	0.91	28.1	0.99	24.8	1.06	27.4
Average Annual	8.59	45.3	11.73	47.1	10.81	46.0	12.02	47.4

Everson, 1968). These figures are based on the 50% probability of a killing (28° F) freeze occurring on or after a particular date in the spring, or on or before a particular date in the fall.

ECONOMY

The economy of the area is almost totally dependent upon agriculture. Summer fallow, conservation uses, and idle land constitutes 21% of the developed land in the area; irrigated pasture accounts for about 12%; and the remaining 67% is predominantly hay, wheat, barley, sugar beets, and potatoes. Also important in the economy of the area is the livestock; including beef and dairy cattle, hogs, sheep and poultry.

GEOLOGIC FRAMEWORK

GEOLOGIC HISTORY

The portion of geologic history pertinent to the study area ranged from late Pliocene time to the present. It was during this period of time that events occurred which determined the characteristics of surface- and ground-water occurrence, movement and quality in the area.

During late Pliocene time, over one million years ago, a lava dam in the vicinity of Raft River created a broad shallow lake which was filled intermittently by streams. When much of the basin had been filled with predominantly fine sand, silt, and gravel, the dam was overtopped and the lake drained. These sediments, termed the Raft Formation, underlie most of the American Falls Reservoir.

It is postulated that the Snake River, which had been flowing near the center of its plain, was forced to flow around the southern limits of a series of basalt flows extruded from vents to the north. At times the Snake River was dammed completely by these flows. A lava dam a few miles downstream from the present American Falls Dam formed a lake in which more than 80 feet of sediments, consisting primarily of clay, silt, and sand, were deposited. This series of basalt flows and associated sediments, overlain by the lake bed sediments were named the Snake River Group and the American Falls Lake Beds, respectively. These events occurred up until the late Pleistocene, less than one million years ago. Since that time the Snake River has been eroding its channel in the basalt and reworking the lake bed sediments until they have assumed the appearance we recognize today.

GEOLOGIC FORMATIONS AND THEIR WATER--BEARING CHARACTERISTICS

Table 2, modified from Mundorff (1967), describes the major stratigraphic units in the area, their geologic characteristics, and their water-bearing capabilities.

The principal aquifer in the area is basalt of the Snake River Group. Aquifers of lesser importance are the American Falls Lake Beds and the Raft Formation. The surface expression of these formations are shown on the generalized geologic map of the area (fig. 4).

HYDROLOGY

SURFACE WATER

The Snake River is the only significant stream in the study area. Only a few wasteways carrying irrigation waste water, and short channels which carry storm runoff to the river constitute the remainder of surface-water flow. Jackson Lake, Palisades and Island Park Reservoirs and other small structures regulate the flow of the Snake River upstream from American Falls Reservoir.

Diversions out of the Snake River for irrigation in the Aberdeen-Springfield area include Aberdeen-Springfield, Peoples, New Lavaside, Riverside, Danskin, Trego, Wearyick, Watson, and Parsons canals. These nine canals or ditches provided 664,130 acre-feet of water for the irrigation of 107,150 acres in 1970, an average of 9.0 acre-feet per acre. The two major canals, Aberdeen-Springfield and Peoples, with an average seasonal diversion of 456,200 acre-feet (Watermaster Reports 1961-1971), serve a total of 83,000 acres, an average of 5.5 acre-feet per acre. The actual acreage irrigated varies from year to year. The 1966 Watermaster's Report lists 48,538 acres irrigated, about 77% of the 63,000 acres under the Aberdeen-Springfield canal, an average of 7.6 acre-feet per acre. It is not known whether the actual irrigated land under other canals in the area vary as much as that under the Aberdeen-Springfield canal.

Diversion of water for irrigation begins during the first two weeks in May, and ends approximately September 30th. Return flow from wasteways along the northwest side of the reservoir begins shortly after the irrigation season begins and remains relatively constant throughout the irrigation season at approximately 300 acre-feet per day.

Canal company reports indicate that the use of surface water for irrigation in the area has declined in recent years. Although most irrigation districts and canal companies in the area were unable to provide specific figures from their records, they did indicate that many of their water users were selling shares in the companies, plowing up ditched areas, and developing ground-water sources for irrigation.

TABLE 2

CHARACTER AND WATER-BEARING PROPERTIES OF GEOLOGIC UNITS IN THE

AMERICAN FALLS RESERVOIR AREA

(Geologic units after Carr and Trimble, 1963)

SYSTEM	SERIES	STRATIGRAPHIC UNIT AND SYMBOL	THICKNESS (feet)	CHARACTER AND DISTRIBUTION	WATER SUPPLY
Quaternary	Recent and Upper Pleistocene	Dune sand, alluvium, terrace deposits, and thin loessial deposits. Qal	0-50	Unconsolidated windblown sand and silt, and fluviatile clay, silt, sand, and gravel discontinuously overlying older formations around the reservoir.	Upstream from the reservoir the coarse deposits yield moderate to large supplies to wells where they occur below the water table. Along the west and southeast sides of the reservoir the deposits are above the water table.
		Unconformity			
	Upper Pleistocene	American Falls Lake Beds Qaf	0-80	Partly consolidated medium- to thin-bedded clay, silt, and fine sand with a persistent but discontinuous thin layer of gravel at the base. Crops out on both sides of the reservoir for many miles above American Falls.	Yields small supplies to domestic and stock wells. Discharges a significant amount of water to reservoir from gravel at base of formation.
		Unconformity			
	Upper or Middle Pleistocene	Basalt of the Snake River Group Qpb	1,000+	Medium- to dark-gray, fine- to medium-grained, commonly vesicular basalt flows, locally separated by basaltic pyroclastic rocks. Lake, playa, and stream deposits interbedded with the flows at some places. Intertongue with and overlie the Raft Formation on the west side of the reservoir.	Basalt flows and pyroclastic rocks (Snake Plain aquifer) yield large quantities of water to wells. The principal source of ground water for irrigation west, north, and northeast of the reservoir.
		Unconformity			
		Raft Formation	75-200+	Light-colored poorly bedded silt and fine sand with a few clay beds, a few local beds of basaltic and rhyolitic tuffs, and some gravel in the lower part. Underlies most of the American Falls Reservoir and extends an undetermined distance west and southwest of the reservoir.	Sandy and gravelly beds yield small amounts of water to wells. Not a principal aquifer in the American Falls area.
		Unconformity			
Quaternary(?)	Pleistocene (?)	Little Creek Formation	15-100	Medium- to dark-gray, dense to fine-grained, somewhat vesicular basalt, and white, buff, red, and brown basaltic and rhyolitic tuff with some conglomerate lenses. Underlies the southwestern part of the area.	Appears to be moderately permeable. Probably a major source of irrigation water, west of American Falls.
		Unconformity			
Tertiary	Middle Pliocene	Walcott Tuff	15-50	White bedded rhyolitic tuff, black obsidian welded tuff, and red welded tuff. Central part perlitic and spherulitic. Exposed in the canyon of the river below American Falls and south of American Falls.	Yields moderate amounts of water to wells.
		Neeley Formation	30-150	Tan to brown, fine- to coarse-grained rhyolitic tuff with lenses of gravel and a few beds of white marl. Exposed in the canyon of the river, but subsurface extent not known.	Sandy and gravelly beds probably yield some water to wells.

GROUND WATER

Ground-Water Development — Ground-water development in the study area has been primarily for irrigation purposes, as well as for domestic and livestock use.

Figure 5, showing cumulative totals of wells by type drilled in the area from 1949 to 1970, gives an indication of degree and type of development occurring. Additional wells are in use, but many of those drilled prior to July 1, 1953, are not included in well driller reports submitted to the Department of Water Administration from whose files figure 5 was derived. On the basis of the 391 reports examined, 134 wells (34%) were 16 inches in diameter, 72 (18%) were 18 inches in diameter, and 62 (15%) were 6 inches in diameter. Irrigation wells range in depth from as shallow as 60 feet to as deep as 495 feet, with most being between 200-300 feet deep. Most irrigation well development has occurred subsequent to 1951 and has been concentrated in the following townships: T2S, R24E; T3S, R32E; T3S, R33E; T5S, R30E; T6S, R30E; and T7S, R30E.

Depths-to-Water — The observed water levels in wells range from flowing to 354 feet below land surface. Generally, the depth-to-water increases with distance from the reservoir (fig. 6) and increases most rapidly with distance from the reservoir at the southern end of the study area west of American Falls Dam.

Some of the factors causing this wide range in depth-to-water are: recharge to the ground-water system from irrigated lands close to the reservoir, topography, lithology of the aquifer penetrated, and the particular aquifer penetrated.

Flowing wells occur in the vicinity of Sterling, while some of the deepest water levels occurred in Townships 5 and 6 South, Range 30 East. The American Falls Lake Beds in the area (fig. 4) may confine deeper aquifers, causing sufficient artesian pressure to force water close to or above land surface. Layers of clay within the fine-grained sediments of the American Falls Lake Beds may also retard water percolating downward, forming perched aquifers. Each of these situations may produce anomalous depths-to-water when compared to surrounding areas.

Yield-to-Wells — Yield-to-well data from pumping well tests were not generally available for wells in the area. Most well owners are aware of the capability of the aquifers involved and rarely require that their wells be test-pumped.

Discharge and drawdown information was available on a number of wells throughout the area. Discharge of a pump, in gallons per minute (gpm), divided by the drawdown observed at that pumping rate, is the specific capacity (SC) of the well and is a measure of the hydraulic efficiency of the aquifer and well. Well yield figures available range from 20 gallons per minute to 3,000 gpm; specific capacities from 16 gpm/ft to 1,570 gpm/ft. The highest yields and specific capacities are from wells completed in basalt of the Snake Plain aquifer; however, yields from alluvial sands and gravels between Blackfoot and Pingree range

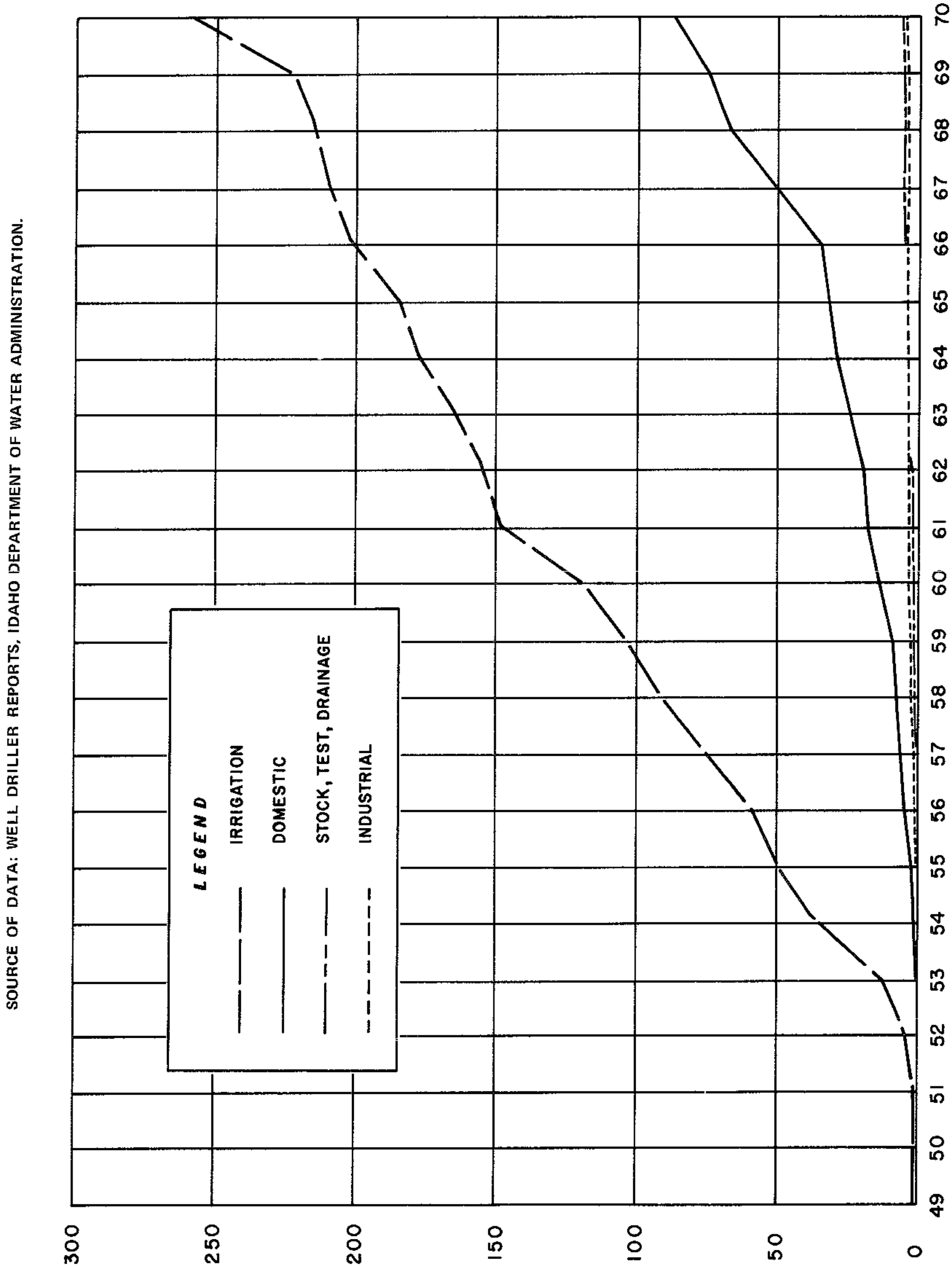

FIGURE 5. Well development in the Aberdeen-Springfield area - cumulative totals of wells by type from 1949-1970.

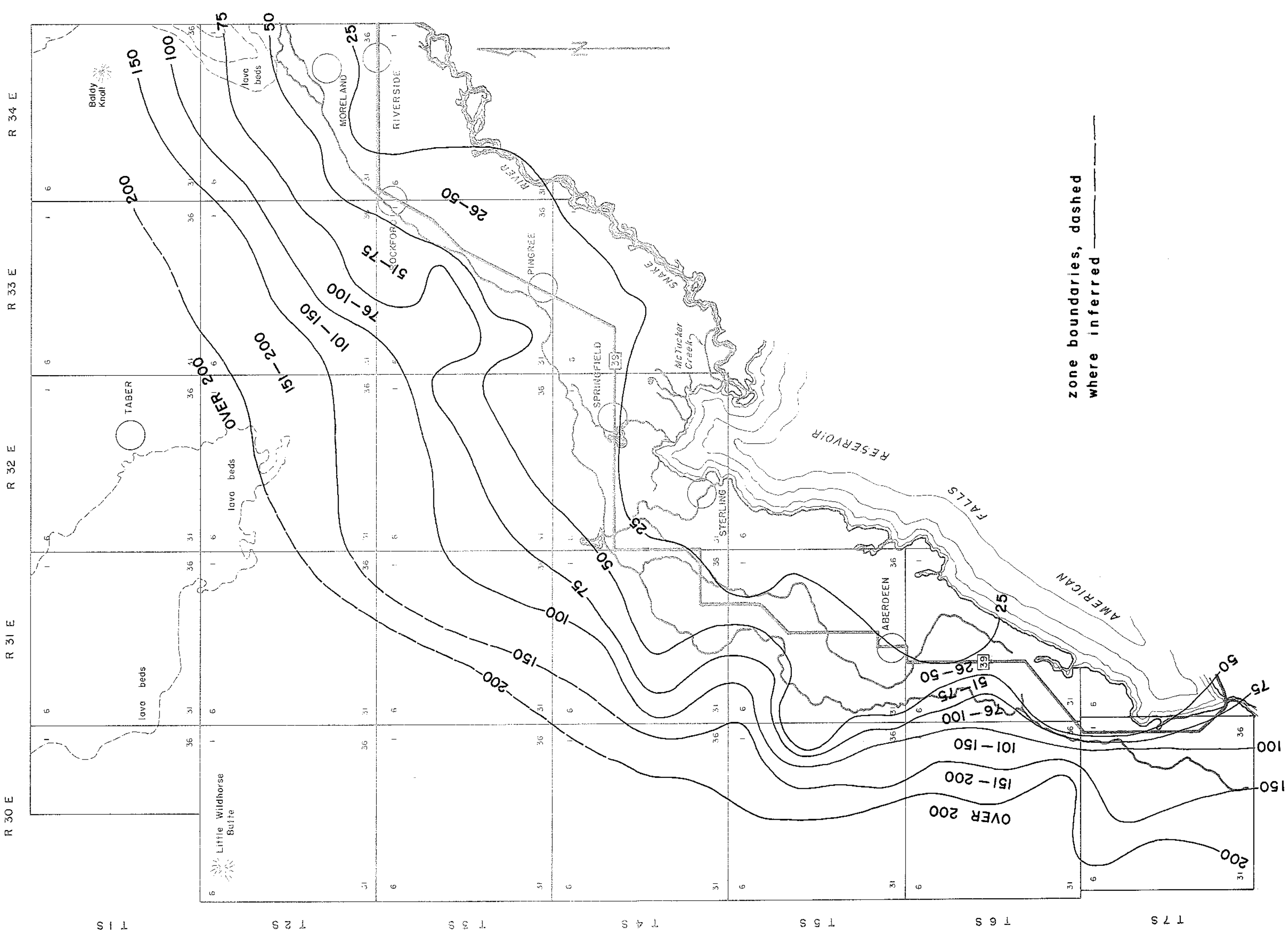

FIGURE 6. Approximate depths-to-water, April 1971, Aberdeen-Springfield area, Idaho.

as high as 900 gpm with little or no drawdown.

Water-Level Fluctuations — Water-level measurements on an area-wide basis were first compiled in 1928-30 by Stearns, Crandall and Steward of the U. S. Geological Survey. Comparing their data with information gathered during the course of this study, it is readily apparent that water levels throughout much of the area have risen, in some areas as much as 12 feet. These comparisons were made using water surface elevations determined at the same time of year and in the same or nearby wells as those used in the 1928 study.

Water-level fluctuations for the period 1952 to 1970 are presented in hydrographs of seven USGS observation wells in figures 7, 8, and 9. A map showing the locations of all observation wells monitored from April through October, 1971, is presented in figure 10. Water levels for the period 1952-1970 show a very modest but definite decline from 1952 until about 1960 or 1961, at which time a steady recovery began. The recovery probably began in response to increased recharge from precipitation, which has shown a noticeable steady increase from year to year since 1961. The decline was probably due, at least in part, to a period of below-normal precipitation from about 1942 to 1960 (fig. 11), leading to reduced recharge to the aquifer. Water surface elevation contours based on measurements made in April, 1971, are presented in figure 12.

Other sources of recharge to the aquifer besides precipitation can include deep precolation of irrigation water, seepage from American Falls Reservoir and the Snake River, canal leakage, and underflow from tributary basins (Stearns, Crandall and Steward, 1938). Timing, quantity, and location of recharge all have an effect on water-level fluctuations.

Lateral changes in permeability, caused by changes in rock type, also play an important part in water-level fluctuations, especially with regard to the fine-grained sediments of the American Falls Lake Beds. Water in these sediments encounters a greater resistance to flow, due to the lower permeability than that of basalt. Recharge to or discharge from an aquifer with low permeability causes water-level changes of a greater magnitude than in an aquifer of higher permeability. Related to an aquifer's permeability, and other important indicators of its efficiency, are its coefficients of transmissivity and of storage. The coefficient of transmissivity is defined as the rate at which water will flow through a vertical strip of the aquifer one foot wide and extending through the full saturated thickness, under a hydraulic gradient of 100 per cent (Johnson, 1972). The coefficient of storage of an aquifer is defined as the volume of water released from storage, or taken into storage, per unit of surface area of the aquifer per unit change in head.

Stearns, Crandall and Steward (1938) conducted a series of well tests to derive an average value for both coefficients of transmissivity and storage for the Snake Plain aquifer. Results of the tests in different areas varied widely, but it was felt that if the Plain was treated as a homogeneous unit, usable values would result. Based on 33 pumping well tests, the average coefficient of transmissivity was found to be 5 million gallons per day per foot of aquifer thickness. Averaging the results of 18 tests gave a value approximating 0.04 for

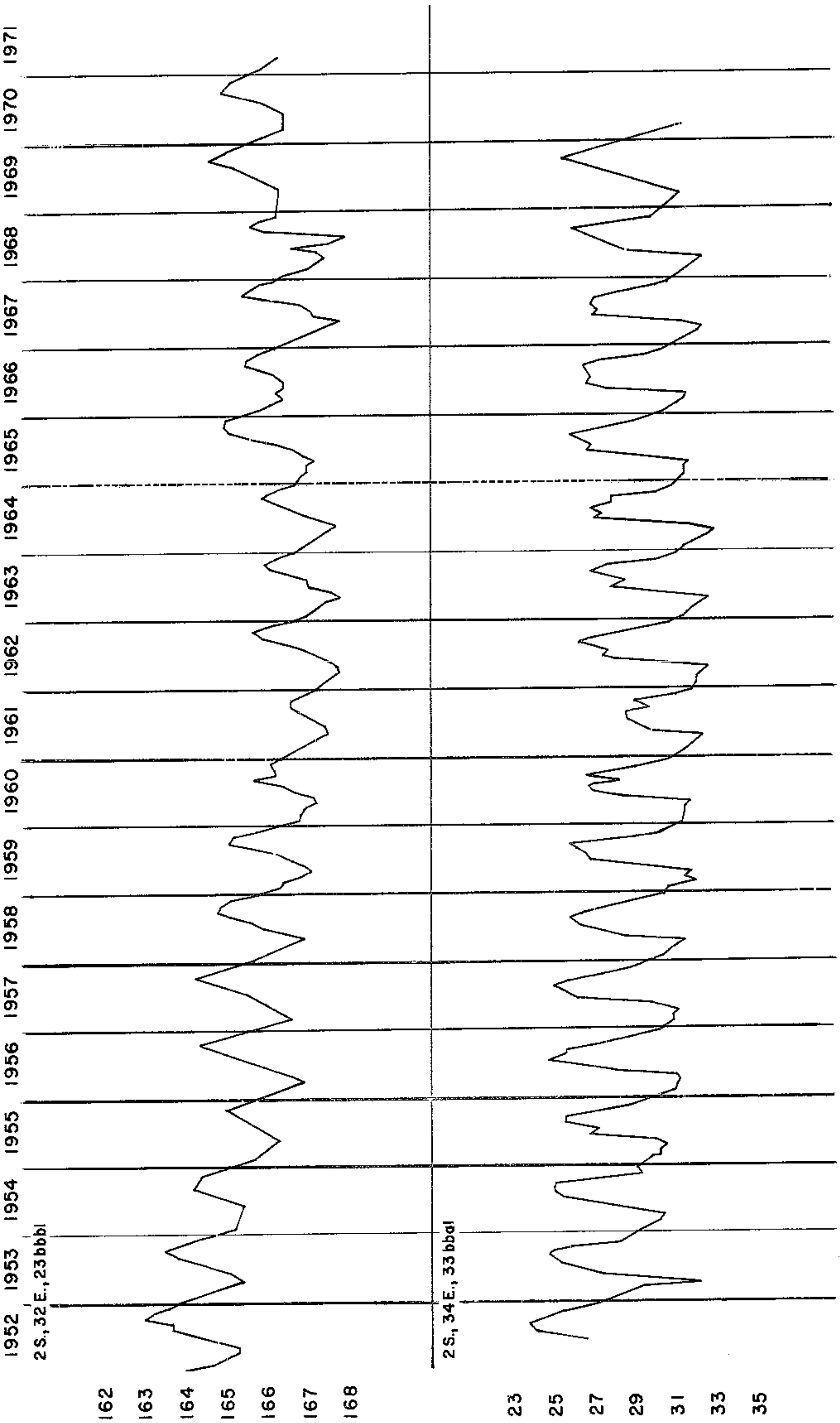

FIGURE 7. Hydrographs for USGS observation wells 2S 32E 23bbb1 and 2S 34E 33bba1, Aberdeen-Springfield area, Idaho.

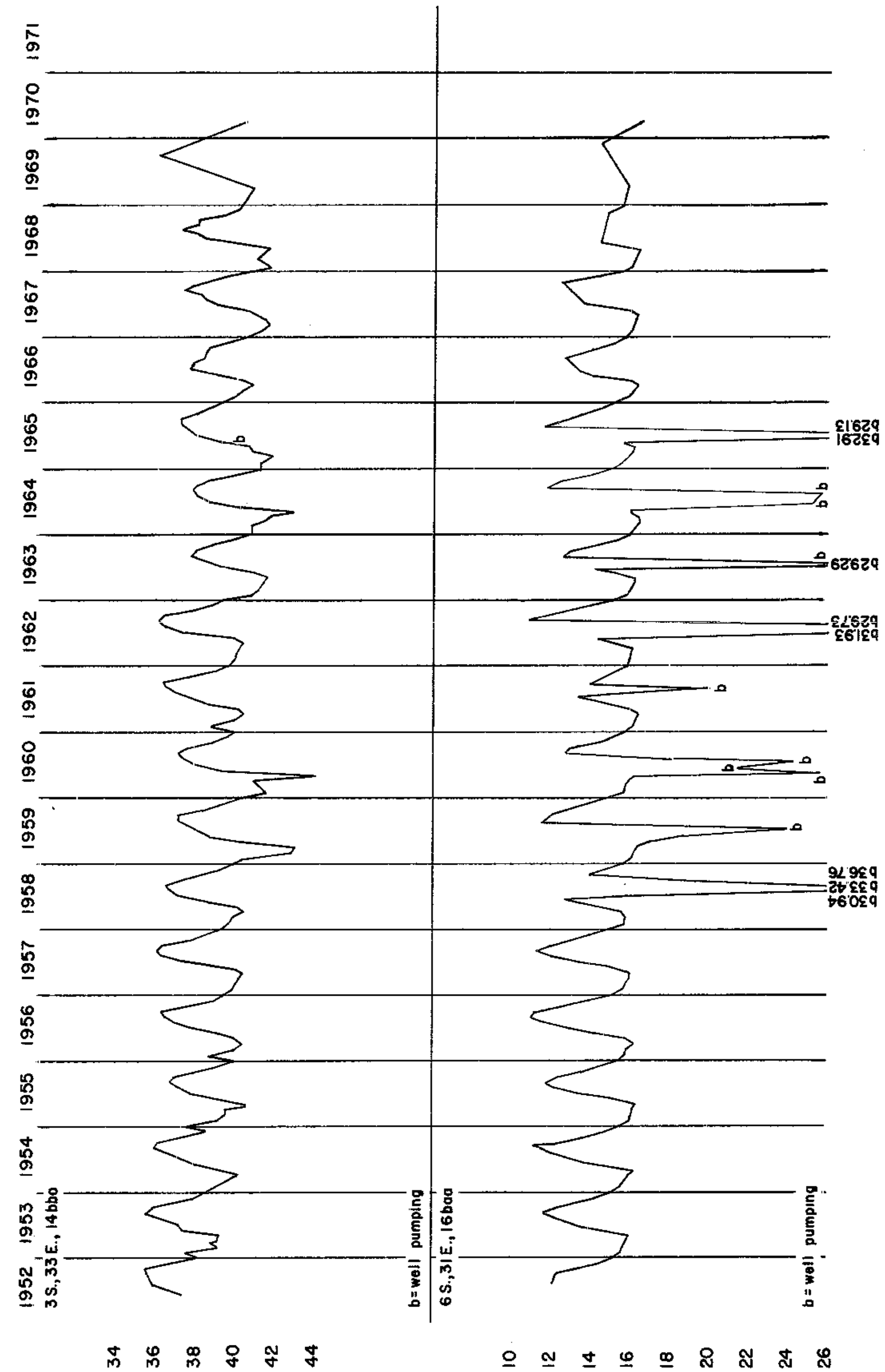

FIGURE 8. **Hydrographs for USGS observation wells 3S 33E 14bba1 and 6S 31E 16baa1,** Aberdeen-Springfield area, Idaho.

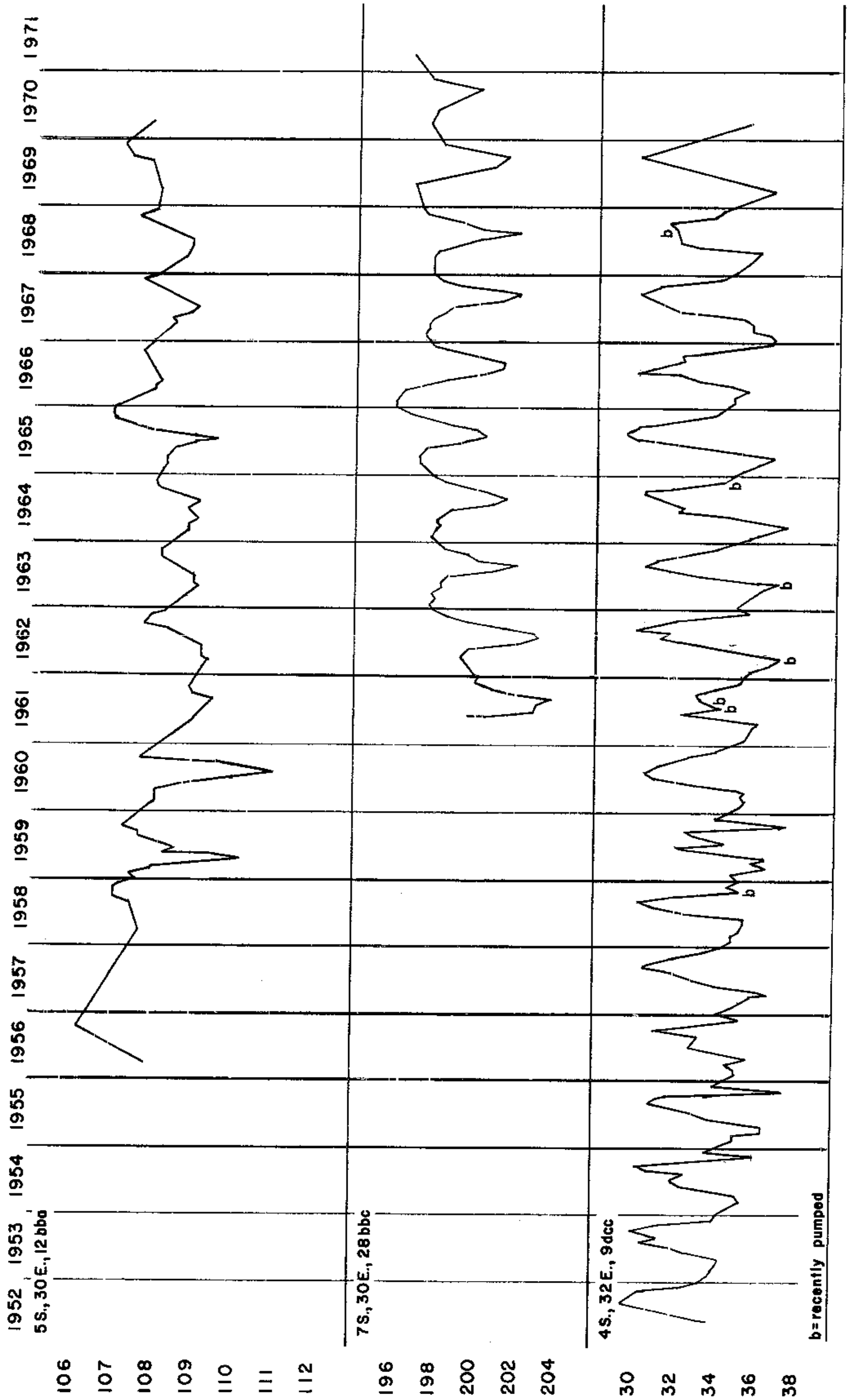

FIGURE 9. Hydrographs for USGS observation wells 5S 30E 12bba1, 7S 30E 28bbc1 and 4S 32E 9dcc1, Aberdeen-Springfield area, Idaho.

FIGURE 10. Idaho Department of Water Administration observation well net, Aberdeen-Springfield area, Idaho.

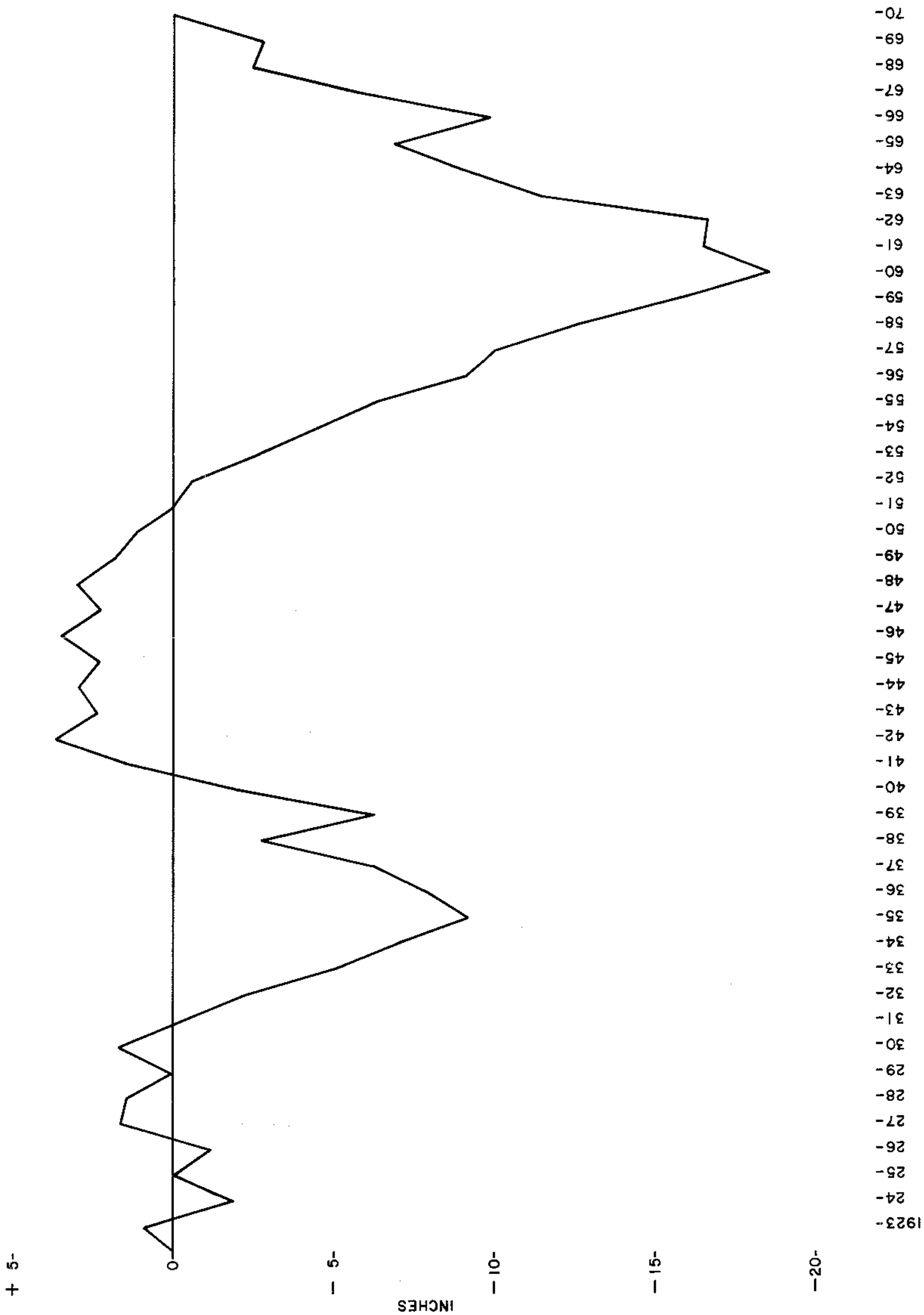

FIGURE 11. **Precipitation - cumulative departures from average for years 1923 to 1970, Aberdeen Experiment Station, Idaho.**

the coefficient of storage. Compared to values for other water table aquifers, the Snake Plain aquifer has a moderately low coefficient of storage, indicating that relatively large water-level changes occur when a given amount of water is added to or removed from storage.

Water levels fluctuate seasonally throughout the area, according to the amount of water added to or removed from storage. Water-level changes between April and October, 1971 ranged from +17 to -4 feet. The April and October measurements were made before pumping of wells began and about a month after pumping ceased throughout the area, so that the effects of withdrawal would be eliminated or minimized. A comparison of figures 12 and 13 will indicate the location and approximate magnitude of the changes.

Shortly after irrigation water is applied to land in the area in May some noticeable changes begin to occur. A ground-water "mound" or ridge begins to form approximately along the axis of the Aberdeen-Springfield canal and becomes very pronounced later in the season. Leakage from the canal recharges the ground-water system to such an extent that water levels in wells in close proximity to the canal are held artificially high. Other changes are the rather localized domes or mounds of ground water in areas away from the canal. These high areas may be indicative of perched water table systems, but examination of logs of wells in the areas are inconclusive. Some apparent differences in water surface elevations can be accounted for by topographic relief, but in most cases, not enough detailed information was available from well logs with which to make a determination.

Based on previously published hydrographs, by spring of the following year water levels recover to the level of the prior year, which indicates that recharge to the aquifers equals or exceeds the rate of withdrawal and natural discharge.

Ground-Water Movement -- Contours of water-level elevation are shown in figure 12. These contours join points of equal elevation on the ground-water surface and show the configuration of the aquifer and the direction of ground-water movement. Since water movement is controlled primarily by gravity, movement will always occur from a higher to lower elevation, in a down-gradient direction. Some flow lines are shown in figure 12, with arrows indicating the direction of ground-water movement. From the water-level contour map and flow lines, it is apparent that water to the east of the Aberdeen-Springfield Canal moves toward the reservoir in a southerly or southeasterly direction, while ground water to the west of the canal moves southwesterly toward the main body of ground water in the Snake Plain aquifer.

Artesian System — Artesian wells, especially those that flow at land surface, are found in the vicinity of Sterling at the northwest extremity of the reservoir in Section 29, Township 4 South, Range 32 East, B.M. Artesian conditions arise where aquifers are overlain by relatively impermeable layers, confining them to the extent that sufficient hydraulic pressure is created to cause water levels in wells tapping the aquifers to rise above the level of the water-bearing formation, in some cases, above land surface.

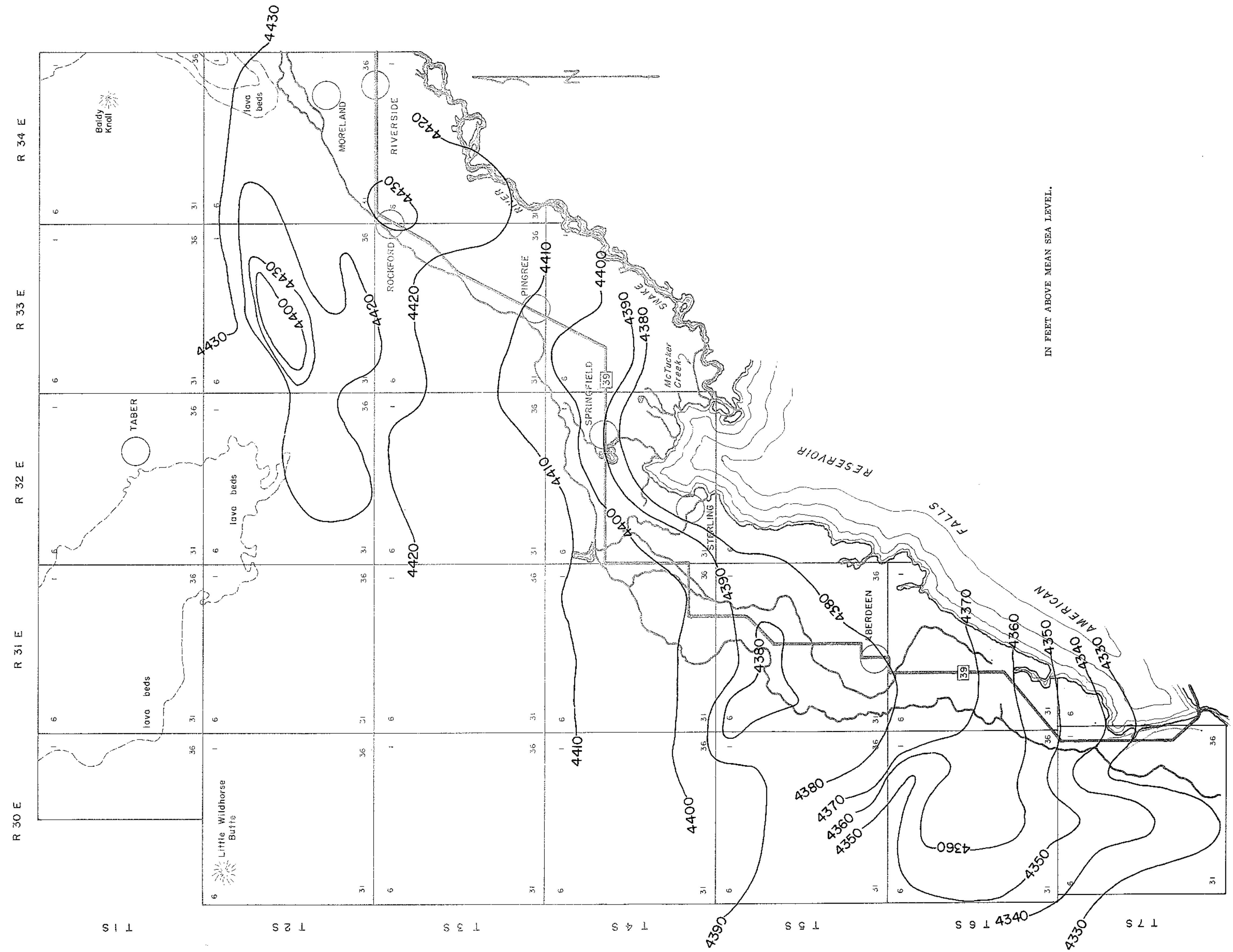

FIGURE 12. Water surface elevation contours, April 1971, Aberdeen-Springfield area, Idaho.

IN FEET ABOVE MEAN SEA LEVEL.

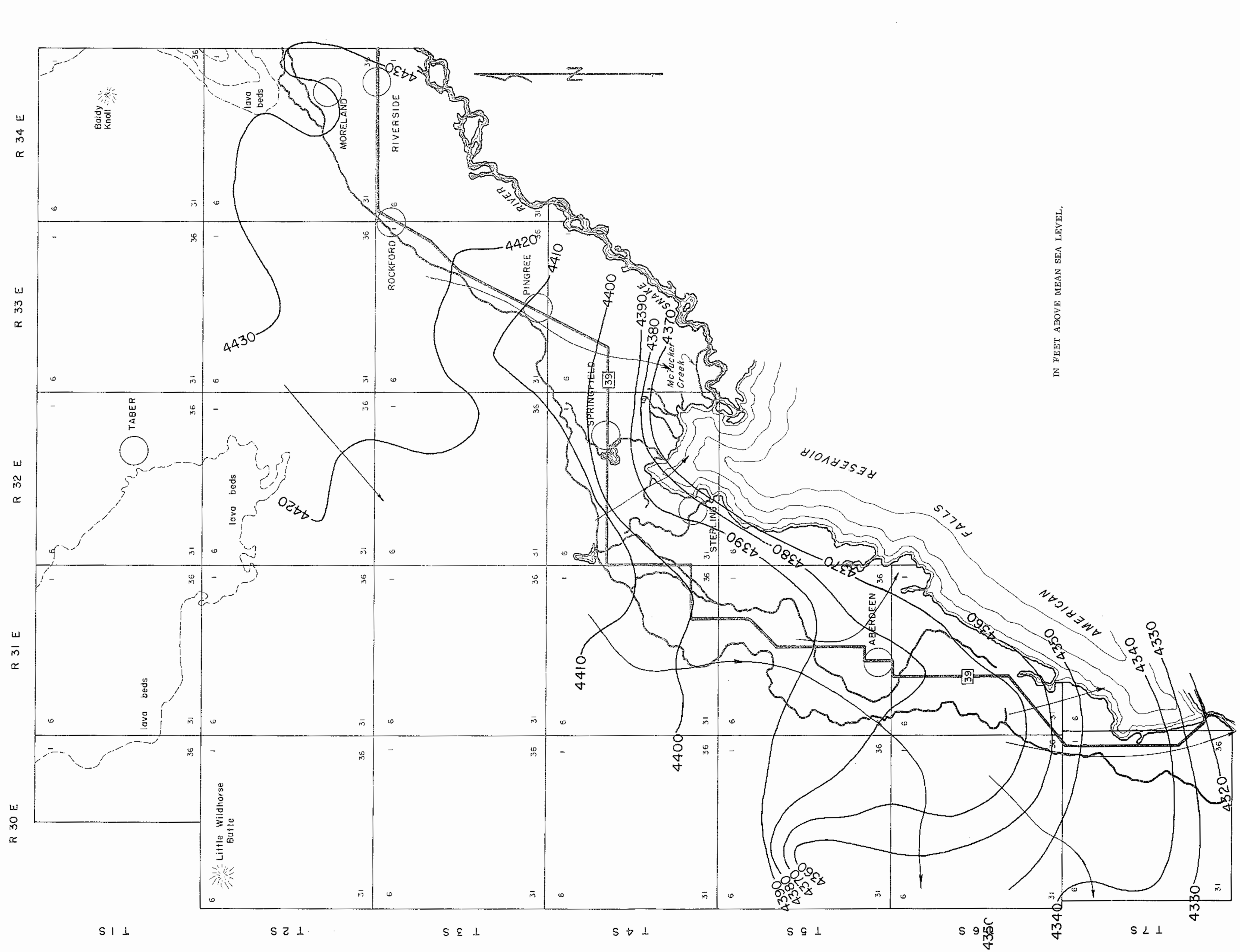

FIGURE 13. Water surface elevation contours, October 1971, Aberdeen-Springfield area, Idaho.

One well in Sterling flows with moderate, though unmeasured, pressure, and one well south of Springfield has been reported by the well driller to flow 900 gpm with a shut-in pressure of 40 pounds per square inch (psi). Many other wells in the vicinity tap artesian aquifers with less hydraulic pressure for their water levels are higher than the regional water table, yet do not rise above land surface.

Artesian wells supply primarily irrigation uses at present, but the artesian system is neither highly developed nor important as a water producer at this time.

GROUND WATER – SURFACE WATER INTERRELATIONSHIP

Ground and surface waters in the study area are closely interrelated, as is evidenced by the numerous large springs at the north and northwest portions of the reservoir. With the exception of one spring issuing from a coarse gravel layer at the base of the American Falls Lakes Beds, almost all the large springs issue from basalt, at or near an elevation of 4,370 feet (Mundorff, 1967, p. 15).

The discharge of a small spring in the SW¼ SW¼ of Section 30, Township 4 South, Range 33 East, was monitored for this study from March, 1971 until November, 1971. During this relatively short period of time, the flow of the spring was constant.

Fluctuations in discharge of springs will normally be caused by fluctuations in recharge to the ground-water system. Generally, springs in the area increase in discharge during the irrigation season, and decline to a relatively constant level throughout the remainder of the year. It is difficult to determine the magnitude of each of the influences on spring discharge, but an analysis of historical record of inflow versus outflow from the reservoir indicates that there has been little or no net effect on the discharge of the springs on a long-term basis. Ground-water development, especially, seems to have had little or no measurable effect. The number of large-diameter irrigation wells has increased very substantially since 1950 (fig. 5) yet inflow to the reservoir has remained relatively constant (table 3).

Ground-water inflow to the reservoir reach was determined using a water-budget approach, whereby ground-water inflow was the unknown quantity. The water budget was calculated using the principle that input to the reservoir will equal output, plus or minus any change in storage.

Inputs include:

1) Flow in the Snake River (measured at Blackfoot)
2) Flow in Portneuf River (measured at Pocatello)
3) Flow in small drainages (Ross Fork, Bannock Creek)
4) Precipitation on the reservoir
5) Ground-water inflow

TABLE 3

AMERICAN FALLS RESERVOIR INFLOW ANALYSES

(Water quantities in thousands of acre-feet)

Water Year	ANNUAL RUNOFF: Snake River at Neeley (+)	Portneuf River at Pocatello (–)	Snake River at Blackfoot (–)	Other Small Drainages (–)	AMERICAN FALLS RESERVOIR: Change in Storage (+ or –)	Precip. on Reservoir (–)	Evapo-ration (+)	Evapotrans-piration (+)	*Ground-water Inflow*
1949	5,277	182	3,089	25	-130	41	136	12	1,958
1950	6,181	277	4,415	35	+391	45	141	8	1,949
1951	6,891	203	4,918	25	+95	35	150	5	1,960
1952	7,385	231	4,776	25	-438	35	165	10	2,055
1953	4,919	189	2,831	25	-95	39	160	10	1,910
1954	4,714	143	2,916	20	+139	32	180	10	1,932
1955	4,595	118	2,258	15	-363	36	160	16	1,981
1956	6,098	156	4,601	20	+359	31	170	11	1,830
1957	5,574	187	3,266	25	-330	42	150	15	1,889
1958	4,540	188	2,529	25	-37	36	155	20	1,909
1959	4,101	146	1,978	20	-166	31	140	35	1,951
1960	4,108	139	2,018	20	-76	31	135	35	2,013
1961	3,214	105	1,437	15	+87	51	113	32	1,859
1962	4,483	140	2,527	20	+164	51	166	16	2,110
1963	4,634	166	2,712	20	+88	75	146	13	1,927
1964	5,274	186	3,392	20	+122	47	167	14	1,953
1965	6,352	245	4,891	30	+548	55	173	8	1,883
1966	5,913	152	3,026	20	-1,014	32	157	33	1,885
1967	4,320	172	2,837	20	+485	58	171	15	1,925
1968	4,802	164	3,114	20	+257	65	168	12	1,897
1969	6,366	240	3,796	30	-512	46	185	19	1,971
1970	5,091	200	3,713	20	+572	62	177	12	1,879

Outputs include:

1) Flow in Snake River (measured at Neeley)
2) Evaporation from reservoir
3) Evapotranspiration from non-inundated area of reservoir
4) Canal diversions (Michaud Canal)

Storage:

1) Change in storage of American Falls Reservoir.

Seepage losses from the reservoir were omitted from the water budget on the basis that they were relatively constant and included only a small percentage of total output. Seepage has been calculated at 80 cubic feet per second (cfs) for maximum reservoir stage and 60 cfs for an average value (Mundorff, 1967). Bank storage was also omitted; while it is important on a short-term basis its significance decreases when a period of many years is considered. While not specifically calculated, bank storage (+ or -) and seepage losses are inherent in the figures for ground-water inflow.

Procedures used in calculation of the water budget were identical to those used by Mundorff (1967) in a water budget estimation of ground-water inflow for the period 1910-1960. All data through 1960 in table 3 is from Mundorff's study; all data subsequent to 1960 is the result of calculations performed during the course of this study.

Diversions to the Michaud Canal from American Falls Reservoir represents gains to the reservoir and, therefore, have been added to ground-water inflow. Diversions, in thousands of acre-feet, to the Michaud Canal for 1958-1970 are as follows:

1958 - 9	1963 - 19	1968 - 21
1959 - 16	1964 - 21	1969 - 25
1960 - 19	1965 - 23	1970 - 22
1961 - 21	1966 - 26	
1962 - 19	1967 - 21	

The conclusion to be drawn from an analysis of the data presented in table 3 is that despite increased irrigation well development in the Aberdeen-Springfield area, ground-water inflow to American Falls Reservoir has shown little change.

WATER QUALITY

GROUND WATER

Ground water in the area is almost exclusively of a calcium bicarbonate type. Water quality data indicate that there is little significant change in the chemical characteristics of the water in its movement through the aquifer, from either outside contaminants or due to the character of the aquifer material itself. There are two localized exceptions to this, however; one in the area north of Aberdeen, the other northwest of Pingree, as will be discussed later.

Electrical conductance (E.C.) which is defined as the ability of a substance to conduct an electric current (Hem, 1970) is measured in units of micromhos (mmhos) per centimeter at 25° Celsius ($^{\circ}$C). Electrical conductance values in the area range from a low of 324 mmhos to a high of 1,210 mmhos. The highest values exist in the area north of Aberdeen and northwest of Pingree.

The area to the northwest of Pingree shows high concentrations of both nitrate and chloride ions, while the area north of Aberdeen has a relatively high concentration of only the nitrate ion (Dyer and Young, 1971). The nitrate ion concentration, however, does not exceed 10 milligrams/liter (mg/l) in either area. This value is well below the limit of 45 mg/l, established as safe for human consumption by the U. S. Public Health Service (1962). Likewise, chloride ion concentrations do not exceed 100 mg/l, also below the suggested maximum limit of 250 mg/l.

Since chlorides and nitrates are not usually present in high concentrations in basaltic aquifers, they are thought to be present in the areas mentioned due either to natural deposits in the American Falls Lake Beds or to various sources of contamination. Nitrate pollution could arise from leaching of nitrate-rich fertilizers. A possible source of chloride, other than local natural deposits, is septic tank effluent.

A useful indicator of the suitability of water for irrigation is the sodium adsorption ratio (SAR) which is defined as follows:

$$SAR = \frac{Na^{+2}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}}$$

The ion concentrations of sodium (Na), calcium (Ca), and magnesium (Mg) in the equation are expressed in milli-equivalents per liter. When the sodium adsorption ratio of each water sample is plotted versus the electrical conductivity, a diagram results which indicates the sodium and alkali hazard present. Figure 14 shows the distribution pattern of SAR values for 30 representative wells, springs, and creeks in the area. All but eight of the samples indicate a medium salinity hazard, and all show a very low sodium hazard. Therefore, this water is of suitable quality for irrigation of most crops grown in the area.

Table 4 is a listing of the chemical constituents of analyzed ground-water samples in the area. All analyses were performed either by the U. S. Bureau of Reclamation or the U. S. Geological Survey.

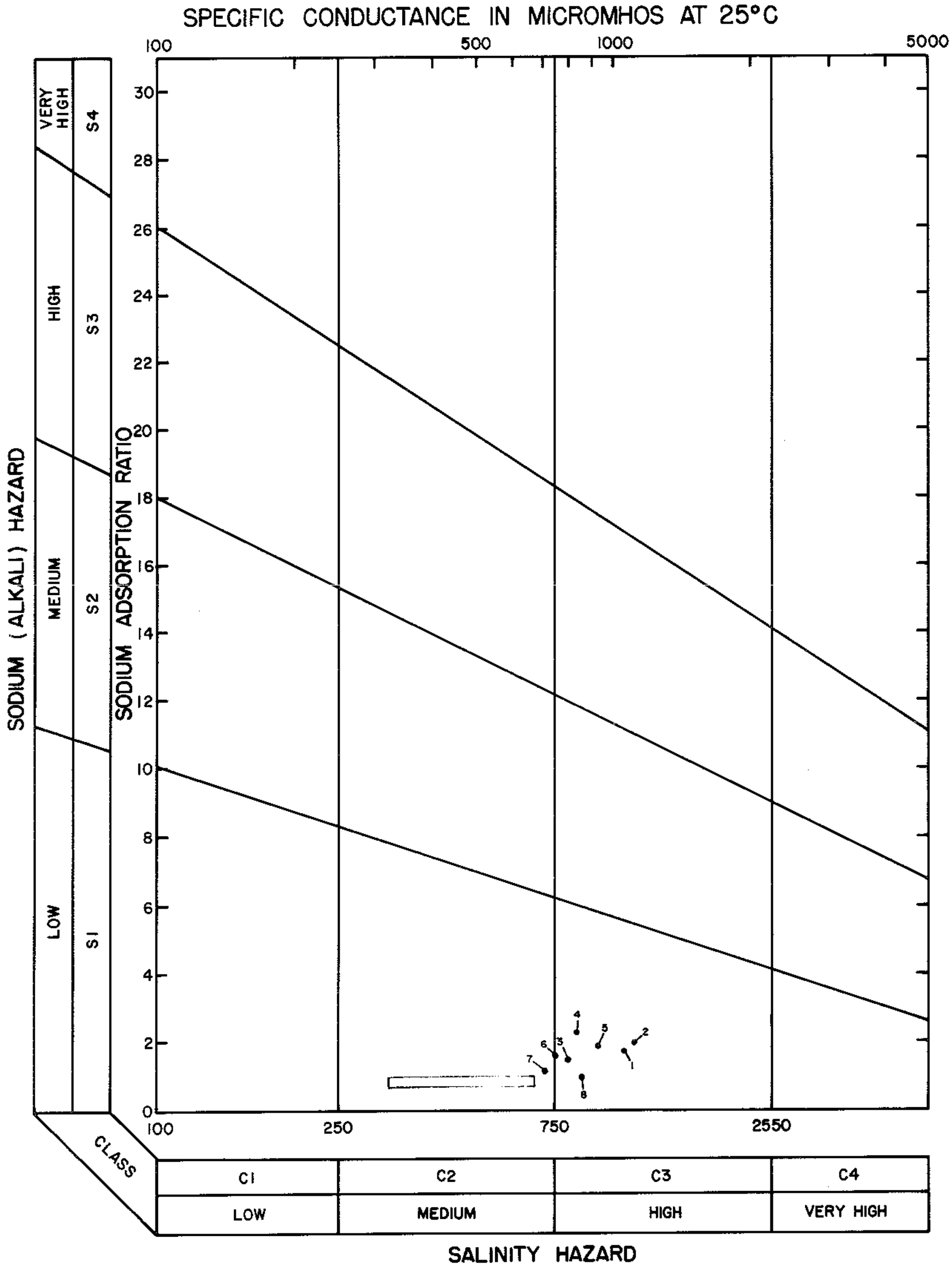

FIGURE 14. Sodium adsorption ratio diagram indicating suitability of water for irrigation in the Aberdeen-Springfield area, Idaho.

TABLE 4

CHEMICAL ANALYSES OF GROUND WATER FROM SELECTED WELLS AND SPRINGS IN THE ABERDEEN–SPRINGFIELD AREA

(Chemical constituents in milligrams per liter)
[Modified from Dyer & Young, 1971]

	Sampling Point Location	Temp. (°C)	Calcium (Ca)	Magnesium (Mg)	Sodium & Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Dissolved Solids	Specific Electrical Conductance (mmhos at 25°C)	Sodium Adsorption Ratio	pH	Alkali Factor	Date Sampled	Analysis By *
1	2S-32E-35abc	9.5	65	20	28	234	57	28	342	588	0.6	7.8	0.48	9/70	B
2	2S-33E-19abc	10.0	64	20	27	243	55	24	341	572	0.6	7.8	0.53	9/70	B
3	2S-34E- 3baa	10.5	68	19	34	268	48	27	360	614	0.8	7.7	.69	9/70	B
4	2S-34E-17aba	10.0	69	19	35	266	52	33	371	607	0.8	7.7	.63	9/70	B
5	3S-32E-13aba	9.5	87	37	82	264	119	127	617	1,090	1.7	7.7	.54	9/70	B
6	3S-33E-29bba		96	38	95	298	122	143	679	1,210	1.9	7.8	.58	9/70	B
7	3S-34E-30cab	10.0	64	18	26	263	40	17	325	562	0.6	7.7	.73	9/70	B
8	4S-31E- 5cbc	10.5	46	16	27	185	43	23	279	468	0.8	7.8	.65	9/70	B
9	4S-31E-22ddb	12.0	53	22	38	234	54	32	345	586	1.0	7.7	.71	9/70	B
10	4S-33E- 4cdd	11.0	65	31	64	332	66	48	476	817	1.5	7.6	.91	9/70	B
11	Danielson Creek (Spring)	12.5	59	23	44	272	55	35	355	696		7.8	.48	9/70	G
12	5S-30E- 8cdc	13.0	32	12	19	149	23	14	208	357	0.6	7.9	.80	9/70	B
13	5S-30E-14bbd	12.0	37	13	21	163	30	13	227	357	0.6	7.8	.74	9/70	B
14	5S-30E-15bac	12.5	33	12	21	155	25	13	213	324	0.6	7.9	.83	9/70	B
15	5S-30E-17ddc	14.0	32	13	22	150	23	16	216	333	0.7	7.8	.84	9/70	B
16	5S-30E-22aac	12.0	36	12	20	159	27	14	220	362	0.6	7.7	.77	9/70	B
17	5S-31E- 9acc	11.0	64	27	89	331	85	63	525	860	2.2	7.7	1.02	9/70	B
18	5S-31E-35dba	12.5	67	43	89	394	130	44	610	969	1.8	7.7	.65	9/70	B
19	Wide Creek	11.0	56	16	23	231	31	18	278	477		8.0	.72	9/70	G
20	6S-30E-11bda	10.5	51	18	25	193	53	25	299	495	0.6	7.8	.51	9/70	B
21	6S-30E-21cac	11.5	42	15	22	170	35	19	248	412	0.6	7.7	.61	9/70	B
22	6S-30E-23dca	10.0	64	22	39	231	63	43	376	646	0.9	7.9	.57	9/70	B
23	6S-30E-33bab	10.5	56	19	26	199	52	30	310	521	0.7	7.6	.50	9/70	B
24	6S-30E-34dbd	10.5	64	22	41	237	65	43	383	680	1.0	7.7	.59	9/70	B
25	6S-30E-35adb	11.0	69	24	58	281	79	48	451	756	1.6	7.7	.77	9/70	B
26	7S-30E- 5bda	10.0	55	19	27	201	56	30	316	537	0.7	7.7	.48	9/70	B
27	7S-30E- 6daa	10.5	53	18	25	193	52	28	300	578	0.6	7.9	.49	9/70	B
28	7S-30E-10bdb	10.5	69	24	49	246	73	60	429	724	1.1	7.7	.58	9/70	B
29	7S-30E-25dad	12.0	92	31	48	231	134	86	534	898	0.9	7.5	.34	9/70	B
30	7S-30E-36dcS1 (Ruegar Springs)	14.0	70	25	49	241	78	66	426	735		7.4	.53	9/70	G

*B - Bureau of Reclamation, G - U. S. Geological Survey

SURFACE WATER

Surface-water quality in the study area is very similar to ground-water quality. Water quality records (table 5) based upon the average of numerous observations at two points upon the Snake River, one above, the other below American Falls Reservoir, indicate that ionic concentrations, temperature, specific electrical conductance, and dissolved solids increase in a downstream direction. In general, E. C. values range from 301 to 428 micromhos, compared to the ground-water range of 324 to 1,210 mmhos. Surface water is also of a calcium-bicarbonate type but has lower sodium adsorption ratios than ground water. These low E.C. and SAR values indicate that surface water in the area is quite suitable for irrigation of all crops that are established in this area.

WATER RIGHTS

Licensed water rights and approved permits for diversion of surface water totals 77 cubic feet per second for irrigation of 4,177 acres as of August, 1971. Decreed water rights involving the Aberdeen-Springfield, Peoples, Riverside, Danskin, New Lavaside, Trego, Wearick, Watson and Parsons canals provide for diversion of an additional 2,743 cfs from the Snake River. The amount of water actually diverted each year is not a constant figure, but is dependent upon the amount and timing of precipitation immediately prior to and during the irrigation season. High soil moisture at the beginning of the season followed by periods of precipitation during the course of the season will substantially reduce the demand for canal deliveries of water.

Licensed water rights and approved permits in the area for the diversion of ground water totals 1,709 cfs for irrigation of approximately 112,371 acres. Claims to ground-water rights total an additional 32 cfs for the irrigation of 1,775 acres.

Licensed water rights and permits for ground-water diversion are shown in figure 15, for surface-water rights exclusive of decrees in figure 16. Licensed and permit amounts are grouped by section within the township and indicate the amount of development in each area. All licensed and permit amounts shown were those on file with the Department of Water Administration as of October, 1971.

CONCLUSIONS AND RECOMMENDATIONS

Information generated as a result of this study, when compared to historical data, indicates that ground-water conditions in the Aberdeen-Springfield area have not been adversely affected by ground-water development over the past twenty years. There are also no measurable indications that the ungaged inflow of springs into American Falls Reservoir has changed significantly during the same period of time. The principal aquifers in the area, basalt and coarse sediments, have not been overdeveloped at this time. Ground-water levels

TABLE 5

CHEMICAL ANALYSES AT SELECTED SURFACE–WATER SITES ON THE SNAKE RIVER, ABERDEEN–SPRINGFIELD AREA

(Chemical constituents in milligrams per liter)

[Modified from Idaho Department of Health records]

Sampling Point Location	Mean	Maximum	Minimum	Sampling Dates Began	Sampling Dates Ended	No. of Samples
Snake River below Blackfoot (Tilden Bridge)						
Temperature, °C	8.5	21.1	0.5	1/28/70	11/14/72	29
Calcium (Ca)	37.2	58.0	13.0	7/ 1/69	3/13/72	24
Magnesium (Mg)	20.2	37.0	12.0	7/ 1/69	3/13/72	24
Sodium (Na)	16.3	34.0	4.0	7/ 1/69	11/14/72	28
Potassium (K)	2.5	7.4	0.7	1/28/70	11/14/72	29
Bicarbonate (HCO_3)						·
Sulfate (SO_4)	24.5	44.0	12.0	7/ 1/69	5/16/72	25
Chloride (Cl)	13.8	28.0	2.0	7/ 1/69	11/14/72	30
Residue	247.3	316.0	172.0	1/28/70	4/11/72	24
Specific electrical conductance (mmhos at 25°C)	301.0	468.0	205.0	5/16/72	11/14/72	5
pH	7.24	8.40	0.00	7/ 1/69	9/12/72	17
Alkali factor	0.79					
Snake River at Neeley						
Temperature, °C	8.9	18.0	1.5	10/11/67	1/24/73	16
Calcium (Ca)	48.5	53.0	43.0	10/11/67	4/21/72	11
Magnesium (Mg)	14.5	18.0	11.0	10/11/67	4/21/72	11
Sodium (Na)	18.3	24.0	13.0	10/ 5/65	4/21/72	12
Potassium (K)	3.5	4.4	2.6	10/11/67	4/21/72	11
Bicarbonate (HCO_3)	197.6	222.0	176.0	10/ 5/65	1/23/73	14
Sulfate (SO_4)	39.3	47.0	28.0	10/ 5/65	4/21/72	12
Chloride (Cl)	16.3	22.0	9.8	10/ 5/65	4/21/72	12
Residue	271.9	314.0	223.0	10/11/67	8/11/70	7
Specific electrical conductance (mmhos at 25°C)	427.6	497.0	329.0	10/ 5/65	1/23/73	17
pH	8.0	8.5	7.3	10/ 5/65	1/23/73	15
Alkali factor	0.62					

have been increasing moderately since 1961.

A noticeable trend in the area is to the use of ground water for irrigation, especially in the case of new land not previously irrigated. However, some land previously irrigated by surface water is now being irrigated by ground water. Where a ground-water source of irrigation water is involved, sprinkler irrigation methods are supplanting flood irrigation techniques, leading to more efficient use of water.

Use of sprinkler systems on a widespread basis may have the effect of reducing the amount of recharge to aquifers, since the total volume of water applied in excess of crop requirements will be less. Reduced recharge may be reflected by a decrease in the long-term rate of rise of water levels, or even by water-level declines. The increased efficiency of water use associated with sprinkler irrigation may also reduce the overall amount of water pumped from aquifers, assuming no large increases in the amount of new land brought under cultivation occur. This may have the effect of mitigating any water-level declines that may occur because of a reduction of recharge.

Pumping lifts of some wells near the western boundary of the area are presently about 350 feet. According to Young and Ralston (1971) the economic pumping lift for the Aberdeen-Springfield and surrounding area is approximately 550 feet. It is apparent that water-level declines greater than any on record for the area would have to occur before pumping water for irrigation would become prohibitively expensive.

With these conclusions and comments in mind, the following recommendations are made:

1. At least a mass water-level measurement be conducted in approximately five years to assess or document any changes in ground-water levels or spring inflow.

2. A specific effort should be made to encourage canal companies in the area to measure return flows throughout the irrigation season and to maintain more accurate records of land irrigated under each canal. With a knowledge of return flows, ungaged spring inflow into the reservoir could be better estimated.

3. An effort should be made to determine the source and magnitude of high chloride and nitrate ion concentrations in the area.

4. It is recommended that no restrictions on permits for the appropriation of ground water be applied at this time in the Aberdeen-Springfield study area.

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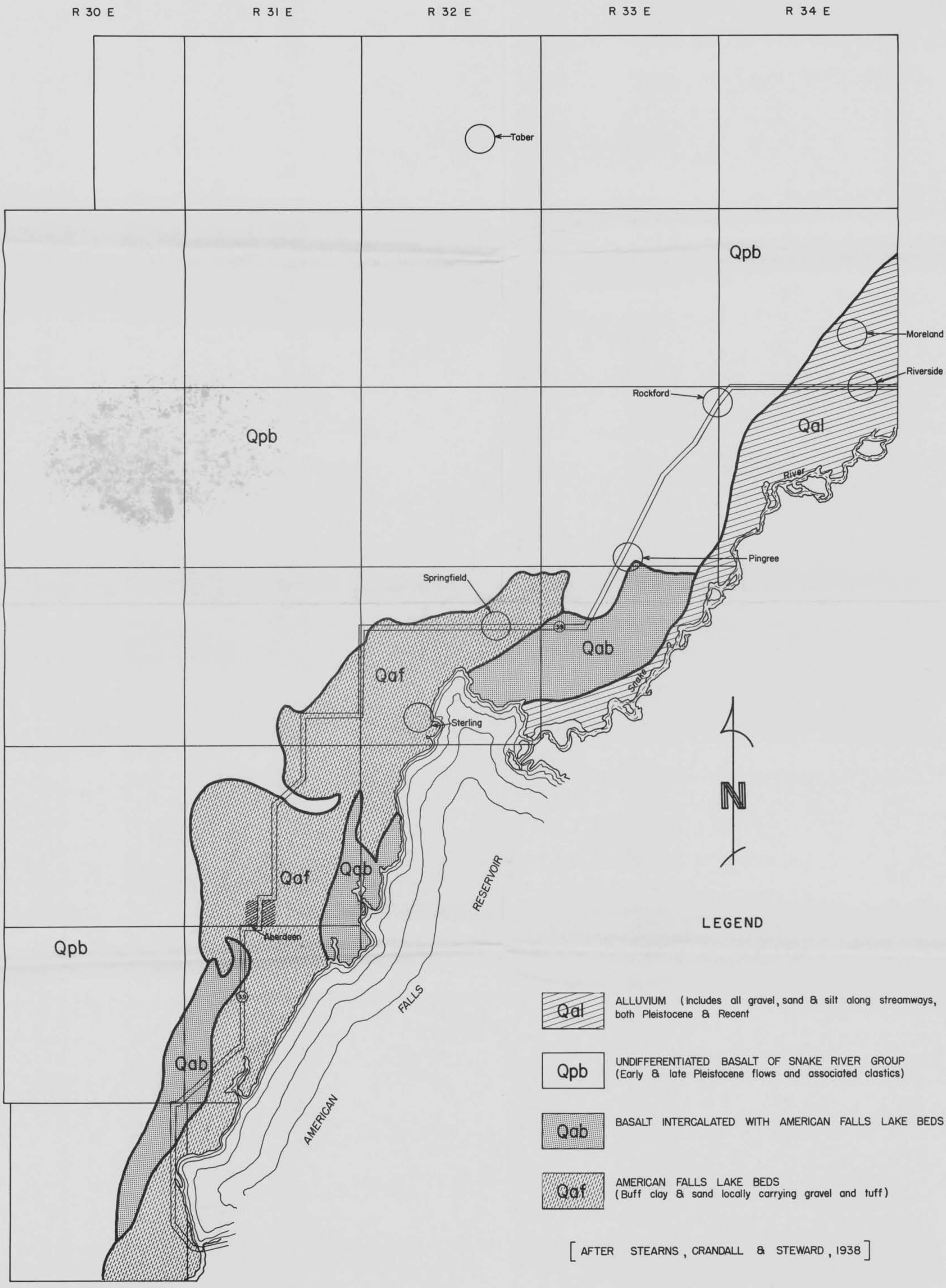
Fig. 4

GENERALIZED GEOLOGIC MAP OF ABERDEEN — SPRINGFIELD AREA



LEGEND

Qal	ALLUVIUM (Includes all gravel, sand & silt along streamways, both Pleistocene & Recent
Qpb	UNDIFFERENTIATED BASALT OF SNAKE RIVER GROUP (Early & late Pleistocene flows and associated clastics)
Qab	BASALT INTERCALATED WITH AMERICAN FALLS LAKE BEDS
Qaf	AMERICAN FALLS LAKE BEDS (Buff clay & sand locally carrying gravel and tuff)

[AFTER STEARNS, CRANDALL & STEWARD, 1938]

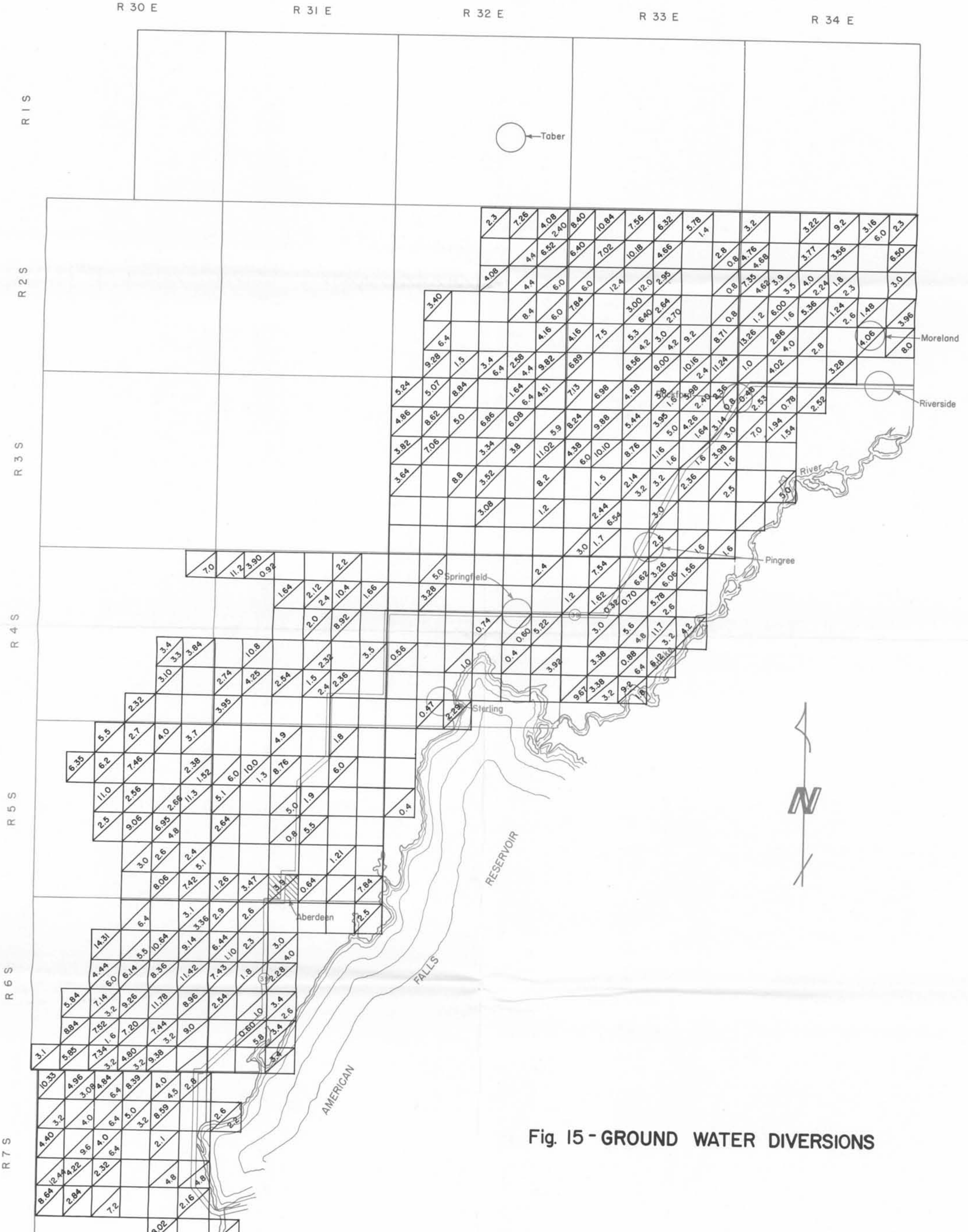


Fig. 15 - GROUND WATER DIVERSIONS

Claims & Licensed diversions in section in c.f.s.

3.64 / 1.03 Permits for diversions in section in c.f.s.

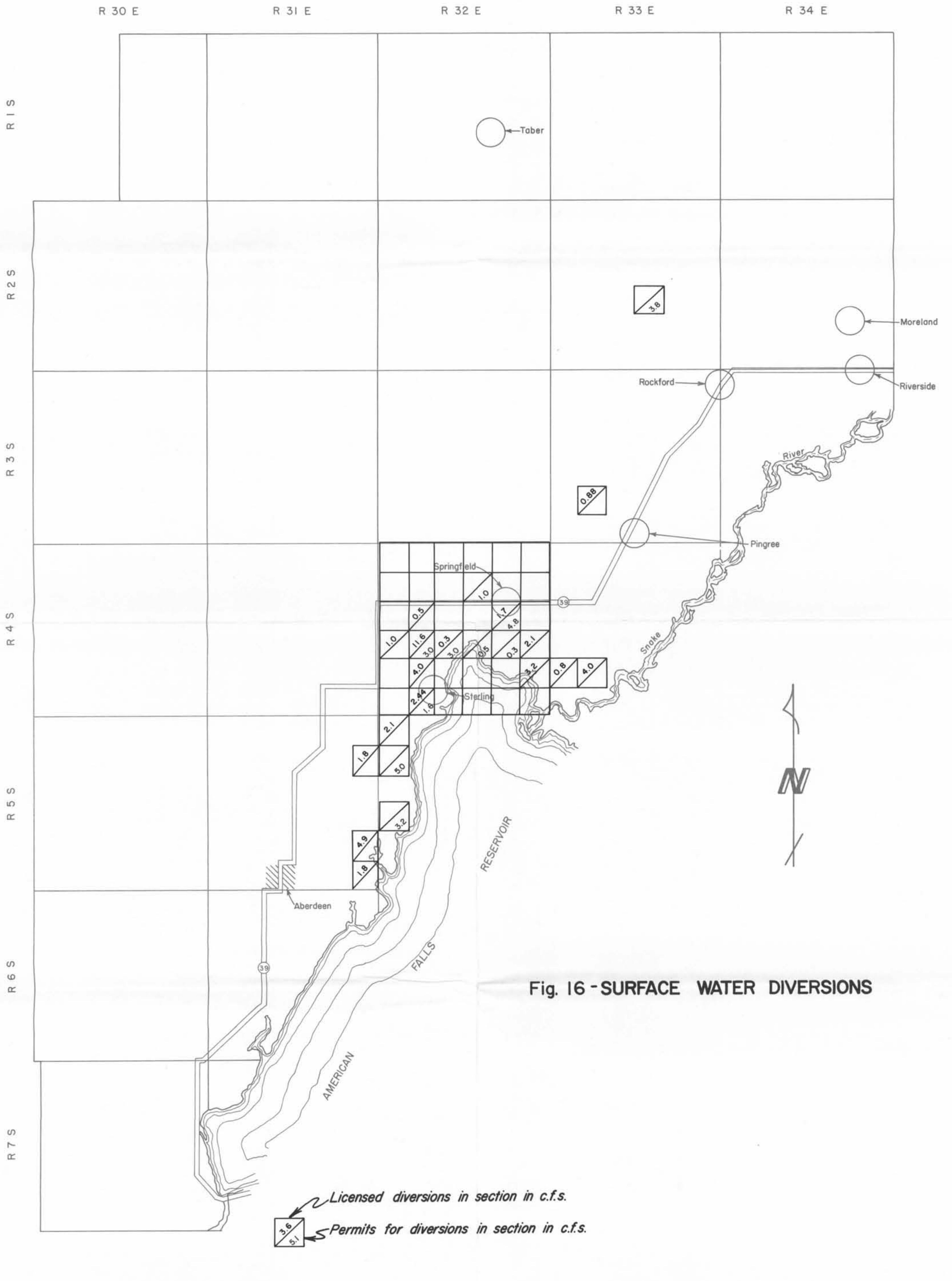


Fig. 16 - SURFACE WATER DIVERSIONS